Deep Space Cryocooler System (DSCS), Phase I Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

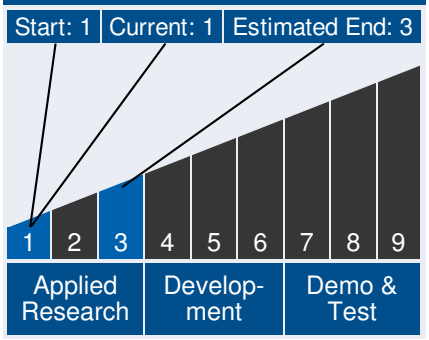
ABSTRACT

As NASA missions continue to extend the horizon beyond near-Earth missions, higher performance systems must evolve to address the challenges of reduced power resources, longer mission durations, higher radiation exposure, and more broadly, harsher space environments. The vision of the low-temperature and input power Deep Space Cryocooler System (DSCS) is to advance the state of the art in Cryocooler systems by developing a low-cost single stage cryocooler, designed to target low heat rejection temperatures (150K) and low cold-tip temperatures (35K), and integrate it with a set of high reliability, micro-sized Low Cost Cryocooler Electronics (µLCCE) customized to operate efficiently at very low power levels (10W). Additionally, the low-cost, light weight, and small size of the DSCS will enable instrumentation on miniature satellite platforms. A key objective of this effort is to develop and demonstrate cryogenic cooling technologies for science measurement capabilities with smaller, more affordable spacecraft and concurrently reducing system risk, cost, size, and development time, consistent with NASA SBIR Science Subtopic S1.09. In the Phase I effort, the uLCCE brassboard will improve upon the mLCCE (TRL6 in 2016) design by evaluating a handful of candidate improvements that will reduce the SWaP requirements of the electronics. Detailed circuit modeling will verify performance of key parameters , which will then inform the final schematic and layout of the uLCCE. The accompanying Thermo-Mechanical Unit will be designed by Lockheed Martin. The conceptual coldhead design leverages their existing TRL 6 Microcryocooler, and will introduce design improvements to target the low heat reject and cold-tip temperatures specified in this solicitation. The design approach will be confirmed with detailed thermodynamic modeling. A prototype uLCCE and upgraded microcryocooler will be built and integration tested in a future Phase II effort.

Table of Contents

Abstract 1
Technology Maturity 1
Management Team 1
Anticipated Benefits 2
Technology Areas 2
U.S. Work Locations and Key Partners 3
Image Gallery 4
Details for Technology 1 4

Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

Continued on following page.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: NASA's Interplanetary, Solar System, and Astrophysics missions are examples of the type of deep-space mission we are targeting with this proposed effort. A complete system that can enable science instruments to be deployed on small, low-cost spacecraft will greatly extend NASA's R&D capabilities. Past MCS and CCS programs laid the groundwork for miniaturization of Iris Technology's CCE, while the DSCS venture will bring that capability to even lower power, smaller size, deep-space missions. The Europa missions could immediately benefit from this product, and as technology advancements are pushing boundaries deeper into Space, the DSCS can also serve as a foundation for future planetary exploration. The New Frontiers initiative has already launched several probes to Pluto, Jupiter, and distant asteroids, and has the future mission scope of exploring Saturn, additional asteroids, or Venus. These destinations would require similar performance targets put forth by this SBIR solicitation. Additionally, NASA is on the verge of launching Mars Cube One, the first demonstration of CubeSats that have flow in deep space. If proven successful, the number of CubeSat missions reaching deeper into space is also likely to increase. The DSCS's small size and weight, and low power requirements make CubeSats an ideal platform, and they would increase the scientific capability of these small satellites.

To the commercial space industry:

Potential Non-NASA Commercial Applications: Iris' Cryocooler Control Electronics portfolio has been gaining increasing interest as measured by the ROM requests we have been receiving from the larger Aerospace Industry. Companies such as Lockheed Martin, Harris Corporation, Honeywell Hymatic, and Raytheon, have all expressed interest in our mLCCE to our larger sized HP-LCCE products, and we expect this interest to grow with an expanded portfolio. The addition of the uLCCE increases

Management Team *(cont.)*

Principal Investigator:

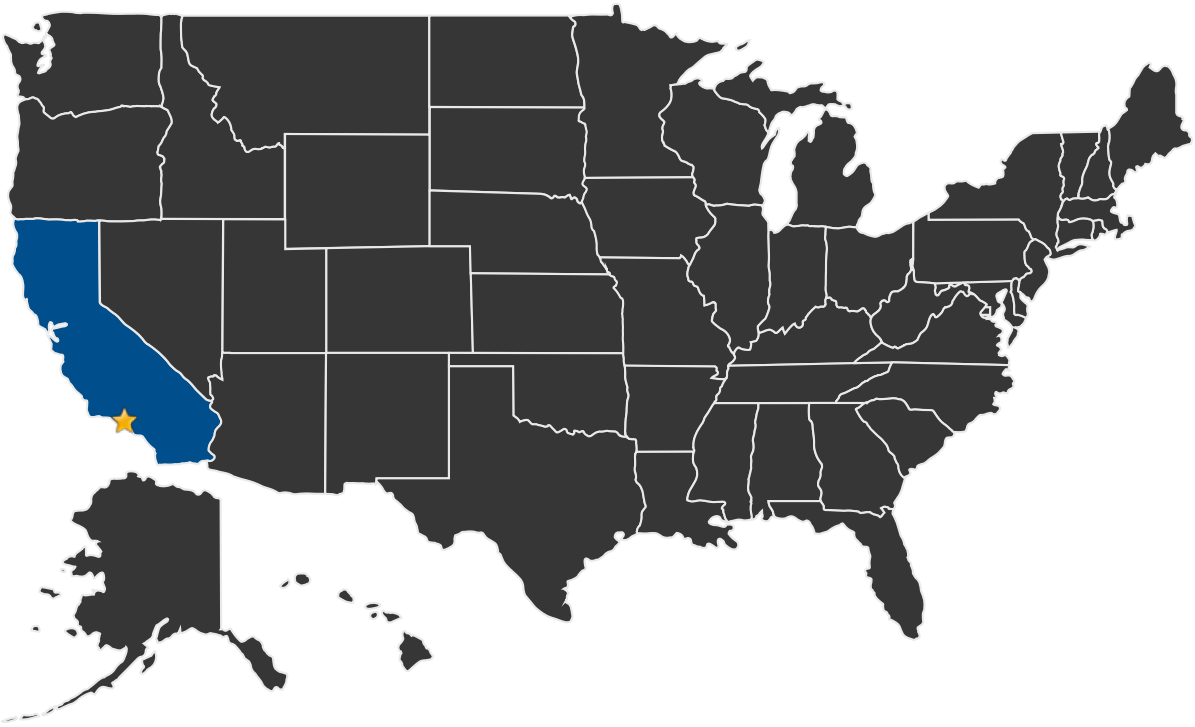
- Mitul Jambusaria

Technology Areas

Primary Technology Area:
Thermal Management Systems (TA 14)
└ Cryogenic Systems (TA 14.1)
  └ Active Thermal Control (TA 14.1.2)

commercial application to both low-power applications with small SWaP requirements, and those applications extending to deeper space. More broadly, the basic uLCCE physical and firmware architectures are supportive of a wide range of mission needs, such as battery charging, heater control, panel actuation, pointing mechanisms, etc. The current potential commercial applications for the DSCS range from supporting imagery and surveillance capabilities, with a strong outlook for additional applications.

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Jet Propulsion Laboratory

Other Organizations Performing Work:

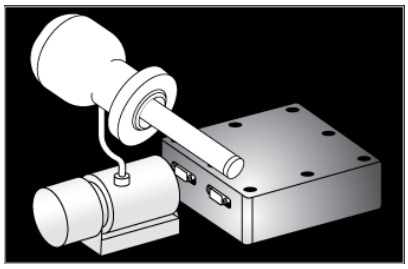
- Iris Technology Corporation (Irvine, CA)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23108)

IMAGE GALLERY



Deep Space Cryocooler System (DSCS), Phase I

DETAILS FOR TECHNOLOGY 1

Technology Title

Deep Space Cryocooler System (DSCS), Phase I

Potential Applications

NASA's Interplanetary, Solar System, and Astrophysics missions are examples of the type of deep-space mission we are targeting with this proposed effort. A complete system that can enable science instruments to be deployed on small, low-cost spacecraft will greatly extend NASA's R&D capabilities. Past MCS and CCS programs laid the groundwork for miniaturization of Iris Technology's CCE, while the DSCS venture will bring that capability to even lower power, smaller size, deep-space missions. The Europa missions could immediately benefit from this product, and as technology advancements are pushing boundaries deeper into Space, the DSCS can also serve as a foundation for future planetary exploration. The New Frontiers initiative has already launched several probes to Pluto, Jupiter, and distant asteroids, and has the future mission scope of exploring Saturn, additional asteroids, or Venus. These destinations would require similar performance targets put forth by this SBIR solicitation. Additionally, NASA is on the verge of launching Mars Cube One, the first demonstration of CubeSats that have flow in deep space. If proven successful, the number of CubeSat missions reaching deeper into space is also likely to increase. The DSCS's small size and weight, and low power requirements make CubeSats an ideal

platform, and they would increase the scientific capability of these small satellites.